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U.S. Department of Transportation

**Federal Aviation Administration**

**Specification**

**Weather Communications Processor  
Hardware Specification**



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## FORWARD

This document specifies the computer hardware and system support software required for the implementation of the Weather Communications Processor (WCP) system. The first computer system will be delivered to the WCP applications software development contractor. The second WCP will be delivered to the Federal Aviation Administration Technical Center (FAATC) for test and evaluation. Additional systems will be installed at Air Route Traffic Control Centers (ARTCC)/Area Control Facilities (ACF) and the FAA Aeronautical Center.

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## 1. SCOPE

1.1 Identification. This specification establishes the functional, performance, test and quality assurance requirements for the Weather Communications Processor (WCP) system. This specification contains the hardware and system support software portion for the design requirements of the WCP system.

1.2 Purpose. The WCP's purpose is to respond to airborne National Airspace System (NAS) users requests for weather products using the Mode Select Beacon System (Mode S) with data link. To perform this function the WCP must decode incoming requests, collect the requested data, assemble the uplink message and route this message to the appropriate Mode S sensor for transmission. In order to support the data link function the WCP will maintain a data base of the selected weather products required to respond to data link user's requests.

1.3 Introduction. An overview of this specification document is as follows:

- |           |   |
|-----------|---|
| Section 1 | This section includes the identification of this document, purpose and introduction.  |
| Section 2 | This section lists the applicable documents referenced in this specification.   |
| Section 3 | This section defines the hardware and system support software requirements for the WCP system as follows:<br><br>3.1 WCP Hardware and System Support Software Definition<br>3.2 System Characteristics<br>3.3 Design and Construction<br>3.4 Documentation<br>3.5 Logistics |
| Section 4 | This section defines the quality assurance provisions.  |
| Section 5 | This section describes preparation for delivery requirements, including packaging and shipping considerations.  |
| Section 6 | This section contains a list of acronyms.   |

Tables and appendices are referenced as appropriate to clarify statements within the body of this document.

The Interface Requirements Documents (IRDs) for external WCP interfaces are separate documents and are listed in section 2.1.3.

## 2. APPLICABLE DOCUMENTS

The documents listed below form a part of this specification and are applicable to the extent described in this document.

2.1 Government Documents. Only the versions of the following Government documents which are in effect on the date of the invitation for bids or request for proposals apply to this specification.

### 2.1.1 Specifications.

#### 2.1.1.1 FAA Specifications.

|                   |   |
|-------------------|---|
| FAA-OR-2802       | Software and Performance Specification for the Weather Communications Processor (WCP) |
| FAA-G-1375        | Spare Parts Particular for Electronics, Electrical and Mechanical Equipment           |
| FAA-G-2100        | Electronic Equipment, General Requirements  |
| FAA Order 6000.27 | Maintenance Philosophy Steering Group Report  |

#### 2.1.1.2 Military Specifications.

|            |  |
|------------|--|
| DOD-D-1000 | Drawings, Engineering and Associated Lists |
|------------|--|

### 2.1.2 Standards.

#### 2.1.2.1 Federal Standards.

|              |  |
|--------------|--|
| FIPS PUB 1-2 | Code for Information Interchange, Its Representations, Subsets, and Extensions |
| FCC Part 15  | FCC Rules and Regulations, Part 15   |
| OSHA-CFR-29  | CFR 1910 OSHA Safety and Health Standards                                      |
| FIPS PUB 25  | Recorded Magnetic Tape for Information Interchange                             |
| FIPS PUB 79  | Magnetic Tape Labels and File Structure for Information Interchange            |

2.1.2.2 FAA Standards.

|             |   |
|-------------|---|
| FAA-STD-019 | Lightning Protection, Grounding, Bonding and Shielding Requirements For Facilities  |
| FAA-STD-020 | Transient Protection, Grounding, Bonding, and Shielding Requirements for Facilities |
| FAA-STD-021 | Configuration Management (Contractor Requirements)                                  |
| FAA-STD-024 | Preparation of Test and Evaluation Plans and Test Procedures                        |
| FAA-STD-028 | Contract Training Program   |

2.1.2.3 Military Standards.

|              |                                     |
|--------------|-------------------------------------|
| DOD-STD-100  | Engineering Drawing Practices       |
| DOD-STD-2167 | Defense System Software Development |
| MIL-STD-889  | Dissimilar Metals                   |

2.1.3 Other Publications.

|                 |   |
|-----------------|---|
| MIL-HDBK-721    | Corrosion and Corrosive Protection of Metals  |
| FAA-RD-80-14A   | The Mode Select (Mode S) Surveillance and Communications, ATC and non-ATC Link Protocols, and Message Formats |
| NAS-IR-43020001 | NADIN/X.25 Packet Mode Users IRD  |
| NAS-IR-25072503 | WMSCR/WCP IRD   |
| NAS-IR-25082503 | ADAS/WCP IRD  |
| NAS-IR-92020000 | CTS/User Systems IRD  |

2.2 Non-Government Documents. Only the versions of the following non-Government documents which are in effect on the date of the invitation for bids or request for proposals apply to this specification.

### 2.2.1 Standards.

|             |   |
|-------------|---|
| ANSI X3.28  | American National Standard Procedure for the Use of Communication Control Characters of the American National Standard Code for Information Interchange in Specified Data Communication Links |
| ISO 7498    | Information Processing - Open Systems Interconnection - Basic Reference Model   |
| CCITT X.224 | Transport Protocol Specification for Open Systems Interconnection for CCITT Applications  |
| CCITT X.25  | Interface Between Data Terminal Equipment (DTE) and Data Circuit-Terminating Equipment (DCE) for Terminals Operating in Packet Mode on Public Data Networks, 1984                             |
| IEEE 200-75 | Reference Designations for Electrical and Electronic Parts and Equipment  |
| EIA-232     | Interface Between Data Terminal Equipment and Data Communications Equipment Employing Serial Binary Data Interchange  |
| EIA-530     | High Speed 25-Position Interface for Data Terminal Equipment (DTE) and Data Circuit-Terminating Equipment (DCE)   |

### 2.2.2 Publications.

|                        |   |
|------------------------|---|
| NFPA 70                | National Electrical Code (NEC) published by the National Fire Protection Association (NFPA) |
| C Programming Language | Kernighan, B.W. and D.M. Ritchie 1978. The C Programming Language. Prentice-Hall.           |
| ANSI                   | C Information Bulletin  |
| AT&T UNIX (System V)   | UNIX System V Reference Manuals. AT&T Technologies, 1983                                    |

2.3 Precedence of Documents. When the requirements of the contract schedule, this document, or subsidiary applicable documents are in conflict, the following precedence shall apply. The contract shall have precedence over all other documents. This document shall have precedence over all subsidiary applicable documents referenced herein.

2.4 Sources of Documents. The following is a list of sources from which documents may be obtained.

2.4.1 Sources of FAA Documents. Copies of FAA specifications, standards, and publications may be obtained from the Contracting Officer, Federal Aviation Administration, 800 Independence Avenue, S.W., Washington, D.C. 20591. Requests should clearly identify the desired material by number and date, and state the intended use of the material.

2.4.2 Sources of Military and Federal Documents. Single copies of unclassified military and Federal specifications, standards, and publications may be obtained from the Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120; or calling (215) 697-3321. Department of Defense (DOD) documents may be obtained from the Department of Defense, Washington, D.C. 20301.

2.4.3 Sources of FIPS and CCITT Documents. Copies of FIPS and CCITT standards may be obtained from:

United States Department of Commerce  
National Technical Information Service (NTIS)  
5285 Port Royal Road  
Springfield, VA 22161 (703) 487-4650

2.4.4 Sources of ANSI Documents. Copies of ANSI standards may be obtained from:

American National Standards Institute  
1430 Broadway  
New York, NY 10018 (212) 354-3300

2.4.5 Sources of EIA Documents. Copies of EIA standards may be obtained from:

Electronic Industries Association  
2001 Eye Street, N.W.  
Washington, D.C., 20006 (202) 457-4966

2.4.6 Sources of NFPA Documents. Copies of NFPA standards may be obtained from:

NFPA  
Batterymarch Park  
Quincy, MA 02269

2.4.7 Sources of Other Documents. Copies of the C Information Bulletin may be obtained from:

CBEMA  
311 1St Street, NW, Suite 500  
Washington, D.C., 20001

### 3. REQUIREMENTS

This specification covers the hardware and system support software necessary to constitute the WCP.

3.1 WCP Hardware and System Support Software Definition. The WCP system consists of one or more central processors and a number of input/output (I/O) devices and mass storage devices. The WCP system shall consist of a number of replaceable units (e.g., processor, memory & power supply). The lowest level of hardware which can be fault detected, fault isolated, and replaced by on-site personnel is designated as a Line Replaceable Unit (LRU).

The functions provided by the WCP central processor shall include the following:

- 1) Processor
- 2) Memory
- 3) I/O controllers
- 4) Communication I/O ports
- 5) Power supplies.

The following mass storage devices shall be included as part of the WCP system and shall be considered LRUs:

- 1) Fixed disk drives
- 2) 9-track magnetic tape drive.

All system elements included in the WCP central processor and the mass storage devices shall be considered critical system elements except for the communications I/O ports (i.e., line adapters) and 9-track magnetic tape drive. The WCP system architecture shall be such that the failure of any critical system element (i.e., LRU) shall not result in loss of data received by, or contained within, the system or any interruption of service exceeding 1 second. An interruption of service is defined as the interruption of the execution of a software task and/or an interruption of the input or output of data. Upon the failure of a critical system element (LRU), the functions performed by, and/or the data stored within, the failed system element shall be restored within 1 second of the failure. The fault detection, fault isolation and fault recovery shall be transparent to the applications software and the WCP system architecture shall prevent the dissemination of corrupted data. Failure of the 9-track tape drive shall not result in any reduction of system performance, except for the inability to write or read data to or from the 9-track tape. Failure of a communication I/O port shall not result in any reduction of system performance, except for the inability to utilize the communications circuit served by the failed communication I/O port.

Each LRU shall contain fault detection capability. This fault detection capability shall include the ability to detect corrupted data. Once a system element (i.e., LRU) failure is detected, the data outputs, except for failure status reporting, of the affected LRU shall be disabled and the function of the failed LRU shall be assumed by other system element(s). The WCP shall then determine if the failure was transient or permanent. If the failure is determined to be transient, the failed element shall be automatically returned to service.

Permanent failures shall result in the failed LRU being automatically removed from active service, a description of the failure being logged, and a failure report being made available for use by the applications software within 5 seconds of the failed LRU being removed from service. The failure report shall include, as a minimum, the identity of the failed LRU and the nature of the failure.

Other WCP subsystems not specifically identified above as LRUs shall also provide fault detection and shall be integrated into an overall fault recovery architecture that is transparent to the applications software. The other WCP subsystems shall include, but are not limited to, the system bus, cooling subsystem, and power distribution subsystems. The failure of any single WCP element within these subsystems shall not result in loss of data or interruption of service greater than 1 second. The WCP implementation shall permit replacement of a failed LRU, excluding the system clock and the backplane, without loss of data or interruption of service.

The WCP system shall include the following additional system elements:

- 1) Cathode Ray Tube (CRT) terminals
- 2) Printer.

The failure of any CRT terminal or printer shall not result in loss of data or interruption of service. The failure of these devices shall not result in loss of WCP capability except for the specific functions normally performed by these devices.

The WCP shall be implemented with a system architecture that will support modular system expansion. The WCP shall be expandable through the implementation of additional processors, memory, mass storage devices, communications ports, and input/output devices.

**3.1.1 Interface Definition.** The WCP is required to interface with a number of different external systems. Interface hardware and communications software shall be provided to support these interfaces. The WCP interfaces to other elements of the National Airspace System shall be consistent with the Open System Interconnection (OSI) Basic Reference Model (ISO 7498). Table 3.1.1-1 summarizes the WCP's interface requirements. The number and type of interfaces required for each specific WCP system shall be as defined in the contract schedule. The required documentation is defined in Section 3.4. All communications software shall be documented and provide an interface to applications software. The compilers provided with the WCP software development system shall include an interface to the communications functions provided with the communications software. Documentation shall be provided for all supplied communications controllers and I/O ports (line adapters) to permit the Government to develop communications software for use with these hardware items. The required software to support the specified communication protocols shall be as defined in 3.1.3 and its subparagraphs.

Table 3.1.1-1  
WCP System Interface Summary

| INTERFACE<br>NAME         | TYPE         | BAUD RATE<br>(b/s) | S/W REQUIRED<br>(Protocol/OSI Layer)                  | PHYSICAL/<br>ELECTRICAL<br>INTERFACE<br>OSI Layer 1 |
|---------------------------|--------------|--------------------|---|---|
| Mode S                    | Synchronous  | 9.6K/56K           | LAPB/Layer 2 of X.25                                  | EIA-530   |
| NADIN II<br>(WMSC & ADAS) | Synchronous  | 56K/64K            | LAPB/Layer 2 of X.25<br>X.25/Layer 3<br>X.224/Layer 4 | EIA-530   |
| (WMSC)                    | Synchronous  | 2400               | X3.28/Layer 2   | EIA-530   |
| MPS                       | Synchronous  | 2400 to<br>56K/64K | LAPB/Layer 2 of X.25<br>X.25/Layer 3                  | EIA-530   |
| Coded<br>Time Source      | Asynchronous | 2400 to<br>9.6K    | (1)   | EIA-530   |
| CRT<br>Terminal           | Asynchronous | 9.6K or<br>greater | (1)   | (1)   |
| Printer                   | (1)          | (1)                | (1)   | (1)   |
| Spares                    | Asynchronous | 1200 to<br>9.6K    | (1)   | EIA-232   |
| Spares                    | Synchronous  | 2400 to<br>56K/64K | LAPB/Layer 2 of X.25<br>X.25/Layer 3<br>X.224/Layer 4 | EIA-530   |

(1) See contract schedule

- Notes: (a) The number of each type of port to be provided is specified in the contract schedule.  
(b) Baud Rates listed as 56K/64K indicate that the maximum baud rate supported by the supplied interface shall be either 56 Kb/s or 64 Kb/s.

3.1.1.1 Mode S Interface. The WCP shall interface with all Mode S sensors designated as primary for that ATC center (ARTCC or ACF). The communications shall be via dedicated telecommunications circuits. The WCP shall use an EIA-530 physical/electrical interface. Software to support LAPB communications protocols (layer 2 of CCITT Recommendation X.25) and as defined in FAA-RD-80-14A, Appendix A, shall be provided. The WCP shall support a full duplex 9.6 Kb/s data rate for each Mode S interface. The supplied interface hardware and communication software shall support data rates of up to 56 Kb/s to support future data rate increases for the Mode S interface.

3.1.1.2 NADIN II Interface. The WCP shall interface with the National Airspace Data Interchange Network (NADIN) II Packet Switch Node collocated within the same ARTCC/ACF. NADIN II is a packet switched telecommunications network that will provide full duplex circuits to interface the Weather Message Switching Center Replacement (WMSCR) and the Automated Weather Observing System (AWOS) Data Acquisition System (ADAS) to the WCP (NAS-IR-25072503 & NAS-IR-25082503, respectively). NADIN II will provide logical and physical interface circuits. Interface hardware and communications software are required to support the WCP interface with NADIN II. The interface hardware shall support synchronous communications circuits with full duplex operation up to a 56/64 Kb/s data rate. EIA-530 shall be used for the physical/electrical interface. The supplied communications software shall support CCITT X.25 communications protocols including layer 2 (LAPB, data link layer) and layer 3 (network layer) and shall conform with CCITT Recommendation X.25 (1984). CCITT Recommendation X.224 transport layer (OSI layer 4) protocol shall be supplied for use on this interface. The WCP shall include the communications capabilities to interface with NADIN II as defined in NAS-IR-43020001. The WCP shall be considered Data Terminal Equipment (DTE) for this interface.

When the WCP systems are initially implemented the NADIN II and the WMSCR systems will not be operational. Therefore, software to support ANSI X3.28 communications protocol (3.1.3.4) shall be provided to support an interim interface with the Weather Message Switching Center (WMSC). This software shall be compatible with the synchronous interface (3.1.1.7) hardware that is supplied.

3.1.1.3 Maintenance Processor Subsystem (MPS) Interface. The WCP shall interface with the MPS collocated within the same ARTCC/ACF. The WCP applications software developed by the Government will provide WCP status and control to the MPS. Interface hardware and communications software are required to support the WCP interface with the MPS. The interface hardware shall support synchronous communications circuits with full duplex operation at 2400 b/s to 56/64 Kb/s data rate using EIA-530 physical/electrical interface. The supplied communications software shall support CCITT X.25 communications protocols including layer 2 (LAPB, data link layer) and layer 3 (network layer) and shall conform with CCITT Recommendation X.25 (1984).

3.1.1.4 Coded Time Source (CTS) Interface. The WCP interface to the CTS shall include an interface port supporting 2400 b/s to 19.2 Kb/s asynchronous operation and having EIA-530 electrical characteristics, as defined in NAS-IR-92020000.

The applications software shall be able to reset the internal real-time clock when necessary, based on the input from the external CTS. If access to the CTS is lost or not available, the internal real-time clock shall be capable of being set manually. Therefore, this interface does not require redundant hardware to satisfy system availability requirements.

3.1.1.5 CRT Terminal Interface. The WCP shall include interfaces for CRT terminals. These interfaces shall have a data rate of 9.6 Kb/s or greater.

3.1.1.6 Printer Interface. Interface ports compatible with the supplied printers shall be provided.

3.1.1.7 Spare Interface Ports. Spare 1200 to 9600 b/s asynchronous interface ports using EIA-232 physical/electrical interface and synchronous interface ports capable of supporting data rates from 2400 b/s to 56/64 Kb/s using EIA-530 physical/electrical interface shall be provided. Communication software shall be provided supporting CCITT X.25 (1984) for OSI layers 2 and 3, and supporting CCITT Recommendation X.224 for OSI layer 4.

3.1.2 Components List. The WCP shall consist of the following system elements:

- 1) Application Processor(s)
- 2) Application Memory
- 3) Mass Storage
- 4) Magnetic Tape
- 5) Communications Interfaces
- 6) Real Time Clock
- 7) CRT Terminals
- 8) Printer
- 9) Cables and Connectors

These system elements are defined in the following paragraphs.

WCP hardware items shall be off-the-shelf, as defined in the contract schedule.

3.1.2.1 - Reserved

3.1.2.2 - Reserved

3.1.2.3 Operational Configuration - Hardware Requirements.

3.1.2.3.1 Application Processor(s) Requirements. The processor(s) shall support a programmable 3-level user-interrupt structure (minimum) to support applications software. This processor shall meet the performance requirements defined in 3.2.1.2.1. The WCP processor implementation shall be modular and shall support subsequent expansion to provide a 200% increase in processing capacity.

3.1.2.3.2 Application Memory Requirements. The WCP shall include, as a minimum, 8 MB of RAM for application program and data storage. The memory requirements of the operating system, any other system support software and supplied communications software shall be in addition to the 8 MB specified. Additional memory shall be provided as required to support fault recovery resulting from a memory LRU failure. This memory shall be in addition to that specified above. Application memory shall, as a minimum, be expandable to 12 MB for program and data storage. The application memory shall meet the performance requirements of 3.2.1.2.2.

3.1.2.3.3 Mass Storage Requirements. The WCP shall include two hard disk drives (primary and backup) with a formatted capacity of at least 200 MB each, not including that required for storage of the operating system and any other required system support software. The WCP shall include primary and backup disk controllers. The drives and controllers shall serve as primary and backup and shall be integrated into an overall system architecture such that in the event of the primary hard disk drive or controller failure, the remaining drive and/or controller becomes primary without loss of data or interruption of service. The system software shall maintain the data stored on the backup drive such that it is identical to that on the primary drive independent of the applications software. The number of hard disk drives shall be expandable from 2 to 8 drives. The hard disk drives shall meet the performance requirements of 3.2.1.2.3.

3.1.2.3.4 Magnetic Tape Requirements. The WCP system shall include one 9-track magnetic tape unit and tape controller. The tape unit and controller are not required to be duplexed. The tape formatting shall conform to FIPS PUB 25 specifications. Tape labels and file structure shall conform to FIPS PUB 79 specifications. The 9-track magnetic tape unit shall meet the performance requirements of 3.2.1.2.4.

3.1.2.3.5 Communications Interface Requirements. The WCP communications interfaces shall be as defined in paragraph 3.1.1. Communications controllers and line adapters shall be provided to support the identified communications interfaces. The number of communications interfaces shall be as specified in the contract schedule. The WCP shall be expandable to support a minimum of 56 synchronous and 56 asynchronous input/output ports. Processing required to support communications protocols shall be separate from application processing requirements. The interfaces shall meet the performance requirements of 3.2.1.2.5.

3.1.2.3.6 Real Time Clock Requirements. Each WCP shall include a real time clock. The output of the real time clock shall be accessible by the application software and the day of year and time of day shall be capable of being set by the application software and by system command. The real time clock shall support dynamically programmable interrupts. The real time clock shall be resettable from the applications software. The real time clock shall meet the performance requirements of 3.2.1.2.6.

3.1.2.3.7 CRT Terminal Requirements. Each WCP system shall include CRT terminals. The number of CRT terminals to be provided with each WCP system shall be as specified in the contract schedule. All system operating functions shall be capable of being performed from any of the CRT terminals. The CRT terminals shall have nonglare screens. The keyboards shall employ a QWERTY layout with separate cursor control keys and numeric keypads. The CRT terminals shall meet the performance requirements defined in 3.2.1.2.7.

3.1.2.3.8 Printer Requirements. Each WCP system shall include a printer with stand. The printer will only be used for system functions such as logging of system failures and printing archive data. The requirements for printer performance are specified in 3.2.1.2.8.1.

3.1.2.3.9 Cable and Connector Requirements. All cables entering or leaving equipment cabinets shall do so through the rear of the cabinet. Cable connectors shall be serviced from the rear of the cabinet. Cables and connectors to support interfaces to subsystems external to the WCP as well as those to interconnect WCP system elements shall be included.

3.1.2.4 Support Configuration - Hardware Requirements. The software development system is an enriched operational configuration system as defined in 3.1.2.3. In addition to the operational configuration hardware the support configuration system shall include the following additional system enhancements.

3.1.2.4.1 Support System Application Memory Requirements. The WCP software development system shall be provided with 12 MB of RAM for application program and data storage. This requirement is in lieu of, not in addition to, the 8 MB of memory required for the WCP operational systems. The memory requirements of the operating system, any other system support software and supplied communications software shall be in addition to the 12 MB specified, and shall be included in the supplied WCP software development system. Additional memory shall be provided as required to support fault recovery resulting from a memory LRU failure. Application memory shall meet the performance requirements of 3.2.1.2.2.

3.1.2.4.2 Support System CRT Terminal Requirements. The WCP software development system shall include additional CRT terminals to support software development. The number of CRT terminals to be provided with the WCP support system shall be as specified in the contract schedule. The CRT terminals shall meet the performance requirements of 3.2.1.2.7.

3.1.2.4.3 Support System Printer Requirements. The WCP software development system requires a high speed line printer to support the WCP software development activity. The printer for the WCP software development system shall meet the performance requirements of 3.2.1.2.8.2.

3.1.3 System Support Software. The software defined below shall be included with all WCP systems. The functions provided by the supplied communications, maintenance and system software shall be accessible by the application software, and shall be compatible with application software generated by the supplied compiler(s) and assembler(s) specified in 3.1.4.1 and 3.1.4.2.

3.1.3.1 Operating System. The operating system shall support the fault detection/isolation capabilities described in this specification, and shall support a multi-tasking multi-user operating environment. The operating system shall be accessible by application software to activate, suspend, spawn, kill and re-prioritize tasks. The operating system shall be designed to support implementation of transaction processing applications software as defined in the Software and Performance Specification for the WCP (FAA-OR-2802). The operating system shall be selected based on the type of applications (e.g., transaction processing) required of the WCP. The operating system shall have a command language. The operating system shall permit commands to be issued directly from connected CRT terminals. The operating system or other system software facility shall provide the ability to edit and to re-enter the last previously entered command. If the fault recovery design requires reallocation of software tasks to available processors in order to recover from a processor failure, the reallocation shall be transparent to application software.

For a multi-processor WCP system, the operating system shall dynamically enable any task to be executed on any processor, and any task shall be able to access all memory, interfaces, and mass storage devices. The operating system shall allow the programmer to assign tasks to available processors to maximize resource utilization. The operating system shall also support assignment of tasks to processors transparent to the application software.

The operating system shall provide convenient access of common shared memory among several application software tasks, and efficient communication between tasks.

The operating system shall permit, without restriction, such simultaneous user operations as text editing, program assembly or compilation, linking and loading programs, or other activities required for software maintenance or performance analysis. The operating system shall support a multi-user interactive programming environment, providing a disk file system, user-accessible input/output operations to all interface devices and efficient intertask program data communications.

3.1.3.2 CCITT Recommendation X.25 Communication Software. Communications software shall be provided that fully supports CCITT Recommendation X.25 (1984) for packet switched networks.

3.1.3.3 LAPB Communications Software. Communications software shall be provided that fully supports the LAPB protocols (OSI layer 2 of CCITT Recommendation X.25 (1984), and as defined in FAA-RD-80-14A, Appendix A.

3.1.3.4 ANSI Standard X3.28 Communications Software. Communications software shall be provided to support ANSI Standard X3.28, subcategory 2.7 and utilizing subcategories A2/A4.

3.1.3.5 Reserved

3.1.3.6 CCITT Recommendation X.224 Communications Software. Communications software shall be provided to support CCITT Recommendation X.224 Transport Protocol. This software shall be usable in conjunction with the required X.25 communications software (3.1.3.2).

3.1.3.7 Maintenance Software. Maintenance software to perform self testing, fault detection, fault isolation, and fault recovery, as specified in 3.2.4.3 and 3.1, is required. The maintenance software shall provide fault detection to the LRU level. The outputs of the maintenance software shall be accessible by the application software.

3.1.3.8 Other Communications Software. Communications software to support the use of the spare communication ports to support asynchronous and synchronous protocols (utilizing the ASCII character subset), shown in Table 3.1.1-1, shall be included.

3.1.4 Support Software for Applications Software Development. Software necessary to permit the efficient creation, maintenance and operation of application and communications software on the WCP processor system shall be included. The following additional software for the WCP software development system, in addition to the support software defined in 3.1.3 is required.

3.1.4.1 Compilers. 'C' language compiler(s) with supporting documentation shall be provided for applications and communications software development. Separate 'C' compilers shall be supplied, if required, for the development of applications software and for communications software. The 'C' compiler(s) shall support either the draft ANSI 'C' standard ('C' Information Bulletin) or be as defined in "The 'C' Programming Language" (Prentice Hall, 1978) for functions defined by Kernighan and Ritchie, plus the extensions defined by AT&T UNIX (System V), 'C' compilers. The 'C' compiler(s) shall produce relocatable program modules compatible with the modules produced by the assembler(s).

3.1.4.2 Assembler. A symbolic assembler(s) to support the development of assembly language applications and communications software modules shall be provided. Separate assemblers shall be supplied, if required, for the development of applications software and for communications software. The assembler(s) shall produce software modules compatible with those produced by the compiler(s). The assembler shall produce relocatable program modules.

3.1.4.3 Symbolic Debugger. A symbolic debugger(s) compatible with the supplied compiler(s) shall be included. The symbolic debugger(s) shall be capable of fully interactive control and monitoring so that a programmer can temporarily alter the logic flow of a program, examine intermediate results, and change data values, without changing the source or object code and without recompilation. The symbolic debugger shall also be capable of debugging for assembly language programs/modules. The debugger shall provide the ability to relate instruction execution to source statement.

3.1.4.4 Text Editor. A full screen text editor for the creation of applications and communications software shall be provided. The text editor shall provide a flexible, multi-user, environment for the development of applications and communications software. The text editor shall support insertion and deletion of text, copying and moving blocks of text, search and replace text functions and moving text between multiple documents.

3.1.4.5 Linking Loader. A linking loader(s) shall be included to link together relocatable modules produced by the supplied compiler(s) (3.1.4.1) and the assembler(s) (3.1.4.2) into executable applications and communications software modules for use with the processor(s) provided, under control of the operating system provided.

3.1.4.6 Library Update Utilities. Utilities shall be included for the creation and maintenance of source code libraries and program module libraries. These utilities shall provide for control over the updates and logging mechanisms suitable for supporting software configuration control. It shall be possible to simultaneously maintain several versions of a software system.

3.1.4.7 Mathematical Subroutine Library. A library shall be included for standard mathematical subroutines including trigonometric, square root, logarithmic and exponential functions. The routines shall be accessible from the assembly and 'C' language provided.

## 3.2 System Characteristics.

### 3.2.1 Performance.

#### 3.2.1.1 - Reserved

3.2.1.2 Performance Requirements. The WCP subsystems shall meet the performance requirements defined in the following paragraphs.

3.2.1.2.1 Application Processor Performance. The WCP processor for operational configuration B shall be capable of applications processing a minimum of 6 MIPS and shall include a hardware-based floating point math processor. Processing required to support the specified communications protocols shall be in addition to the processor performance requirements defined above.

3.2.1.2.2 Memory Performance. All WCP memory shall include error detection/correction facilities. For each fetch of a 32-bit storage word, these facilities shall detect and correct all single-bit errors and detect all double-bit errors. No further processing shall be performed on data derived from memory references which result in errors which are detected, but not corrected. During power interruptions or fluctuations, the contents of the WCP memory shall be preserved for at least 30 seconds. Memory preserved in this manner shall be maintained in an uncorrupted state suitable for automatic restart of normal system operation following restoration of normal line power.

3.2.1.2.3 Mass Storage Device Performance. The hard disk average access time shall not exceed 55 msec. The instantaneous data transfer rate shall be 1 MB/sec, minimum.

3.2.1.2.4 Magnetic Tape Drive Performance. The WCP processor system shall include a 9-track magnetic tape unit and tape controller. This unit shall support a recording density of 1600 bits per inch, phase encoded. The total maximum storage capacity, per tape, shall be at least 40 MB. The tape unit and controller are not required to be duplexed.

3.2.1.2.5 External Interface Performance. The WCP interface to the Mode S sensors shall use LAPB protocol as defined in FAA-RD-80-14A, Appendix A. The hardware interface undetected bit error rate for both received and transmitted data shall not exceed 1 undetected error in  $10^9$  information bits.

The WCP interface to NADIN II and synchronous spare interfaces shall each provide a minimum of 256K of buffering. A minimum 64K of buffering shall be provided for each of the remaining synchronous and asynchronous interfaces. The communications buffering memory requirements are in addition to the application memory requirements.

3.2.1.2.6 Real Time Clock Performance. The real time clock shall provide day of year and time of day in Universal Coordinated Time (UTC) to one millisecond resolution and accurate to within 20 seconds in 30 days of operation. The real time clock shall include battery backup such that accurate time is maintained with power interruptions of up to 48 hours.

3.2.1.2.7 CRT Terminal Performance. The video display shall be monochrome and the screen size shall be 12 inches minimum measured diagonally. The screen format shall be 80 columns by 24 rows minimum, with 96 displayable text characters (ASCII character subset), minimum. A minimum of 10 user-definable function keys shall be provided. The CRT terminal shall be able to support the 32 ASCII control characters as defined in FIPS PUB 1-2. The video display terminal shall have a 9.6 Kb/s interface rate, minimum.

### 3.2.1.2.8 Printer Performance.

3.2.1.2.8.1 Operational System Printer Performance. The printer line width shall be 132 characters with 10 characters per inch. The printing speed shall be 300 characters per second, minimum. The printer shall support, as a minimum, 96 text characters (ASCII character subset) and the 32 ASCII control characters as defined in FIPS PUB 1-2. The acoustic noise generated by the printer when operating (printing) shall not exceed the sound pressure limits specified in FAA-G-2100. An acoustic printer enclosure may be used if necessary to meet this requirement.

3.2.1.2.8.2 Support System Printer Performance. The WCP support system for software development requires a higher performance printer in addition to the printer of the type required at the operational WCP sites. This higher performance printer provided for the WCP support system shall operate at 300 lines per minute, minimum, with 132 characters per line, minimum. As a minimum, the printer shall print 96 text characters (ASCII character subset) and the 32 ASCII control characters as defined in FIPS PUB 1-2.

### 3.2.2 Physical Characteristics.

3.2.2.1 Weight Limits. The cabinets and frames shall be designed for an average weight distribution of floor loading not to exceed 250 lb/ft<sup>2</sup>.

#### 3.2.2.2 Dimensional Limits.

3.2.2.2.1 Accessibility. Equipment units shall provide front access, or rear access, or both, as needed for maintenance and repair activities.

3.2.2.2.2 Access Clearance. Distance required for maintenance access between rows of equipment units shall be no less than 2 feet (0.6 m) for front and rear access if required. Distance required for front access shall not exceed 4 feet (1.2 m) and distance required for rear access shall not exceed 3 feet (0.9 m).

3.2.2.3 Durability. The structural strength and rigidity of the equipment units shall be such that common carrier handling in loading, shipping, unloading, and setting into position for installation will not cause damage to any WCP component nor deformation to the equipment units.

3.2.2.4 Power Requirements. The WCP shall operate on either of the FAA-supplied electrical power services available within the ARTCC/ACF. The power consists of either 120 VAC  $\pm$  10 percent, 60 Hz  $\pm$  2 percent, single-phase three-wire service, or 208 VAC,  $\pm$  10 percent, 60 Hz  $\pm$  2 percent, three-phase four-wire service. These services will be provided from a site-available Power Conditioning System (PCS). Overload protection and further distribution shall be designed within the WCP. WCP power distribution requirements are:

- 1) The WCP shall be designed to minimize the phase-to-phase load imbalance for three-phase power and meet the Federal load balance specified in FAA-STD-020.
- 2) Each equipment unit shall be provided with a single circuit breaker for supply-power overload protection, as well as a visible circuit breaker indicator.
- 3) Each equipment unit shall provide for the distribution of electrical power within the unit.
- 4) Power distribution shall be in accordance with the National Electrical Code (NFPA-70).
- 5) Circuit breakers shall be provided with a mechanical shield to prevent accidental tripping.
- 6) Design of the WCP shall be such that the removal of power from any component cannot damage that or any other component.
- 7) Utility outlets provided in the equipment cabinets shall be on a separate breaker and separate from the operating equipment.

#### 3.2.2.5 Electrical Grounding/Interfacing.

3.2.2.5.1 Grounding and Bonding. The WCP system grounding and bonding shall be in accordance with FAA-STD-019 and FAA-STD-020. WCP grounding and bonding shall be compatible with that of other equipment interfacing with the WCP.

3.2.2.5.2 Grounding Networks. The WCP shall have at least four grounding networks:

- 1) AC ground
- 2) Chassis ground
- 3) Signal ground
- 4) Circuit ground.

3.2.2.5.2.1 AC Ground. A common AC ground derived from the AC power source in the ARTCC/ACF shall be used for all AC power in the system. The WCP AC neutral shall be kept separate from the equipment frame and signal grounds. The FAA will furnish the single point earth ground and the AC power ground at each site.

3.2.2.5.2.2 Chassis Ground. All surfaces of panels, chassis, frames, and cabinets shall be at a common chassis ground potential. The ground for equipment located at operating positions shall be connected to the common chassis ground potential. The WCP chassis ground shall be isolated from AC neutral and shall be connected to DC or signal ground. The chassis ground shall be connected to the ARTCC/ACF ground system. All frame surfaces that are fastened together shall be treated to provide non-oxidizing contact surfaces so that an acceptable chassis ground is achieved. WCP equipment units shall have a ground bus.

3.2.2.5.2.3 Signal Ground. The WCP DC and signal ground shall be connected together and shall be connected to each WCP equipment chassis. The signal ground system shall not be used to provide signal return paths.

3.2.2.5.2.4 Circuit Ground. Communications trunk circuit equipment shall have a separate ground system. When the WCP interfaces with common carrier facilities, the circuit ground shall be connected to the common carrier grounding system.

3.2.2.5.2.5 Return Paths. Each signal and control cable shall be provided with a minimum of one return path. Separate wires shall be used for power supply returns. Outer conductors, shields or equipment cases shall not be used as signal or power return paths.

3.2.2.5.2.6 Electrostatic Discharge (ESD). WCP equipment accessible by users shall be immune to ESD from personnel bearing a static charge.

3.2.2.6 Wiring. All WCP equipment and wiring shall be in accordance with the applicable portions of the National Electrical Code NFPA-70.

### 3.2.2.7 Cooling.

3.2.2.7.1 Internal Temperature. The internal temperature of an operating WCP shall stay within the operating limits of all WCP components without requiring special cooling equipment other than forced-air cooling using room temperature air.

3.2.2.7.2 Airflow. All equipment shall use simple cooling techniques based on conduction, radiation and free convection, using room air, to the maximum extent possible. Forced air cooling shall be used only when free air cooling is inadequate.

3.2.2.7.3 Forced-Air Cooling. Only explosion-proof motors shall be used to drive WCP fans or blowers if forced-air cooling is used.

3.2.3 Reliability. The Mean Time Between Critical Failures (MTBCF) of the WCP System shall be at least 7500 hours. Critical failures resulting from hardware or operating system software failures shall be included in the determination of the MTBCF. Critical failures are defined as the partial or complete loss of a WCP function or capability as defined in 3.1 and 3.2. Interruptions of normal WCP operation of 1 second or less due to the failure of a WCP system element for which redundancy exists shall not be counted as a critical failure unless data is lost or corrupted.

The Mean Time Between Failure (MTBF) for non-critical equipment (tape drive, CRT terminal and printer) shall be at least 7500 hours.

### 3.2.4 Maintainability.

3.2.4.1 Mean Time to Restore (MTTR). The WCP shall achieve a MTTR of 0.5 hours, maximum, for all hardware repairs and restoration of service. When a failure of the WCP operating system software occurs, the functions of the operating system software shall be restored within 5 minutes, maximum. When such a failure of the operating system software occurs, it shall be assumed that in addition to the 5 minutes, maximum, required to restore the functions of the operating system, 5 additional minutes will be required to restore the operation of the application software. Thus, the total MTTR resulting from an operating system failure shall be 10 minutes, maximum.

3.2.4.2 Line Replaceable Unit (LRU). Equipment in the WCP shall be designed to expedite restoration of a system function interrupted through on-site replacement of LRUs (see Section 3.1).

3.2.4.3 Fault-Isolation. The system shall incorporate automatic fault-isolation capabilities using Built-In Test Equipment (BITE) using Built-In Test (BIT) such that 90% of all failure occurrences shall be isolated to the single, faulty LRU, and 95% to no more than two LRUs.

3.2.4.4 Preventive Maintenance. Preventive maintenance shall not interrupt the performance of any WCP system function. Preventive maintenance shall not be required more than 4 times per year.

3.2.4.5 Corrective Maintenance. Corrective maintenance to correct critical or non-critical hardware or software failures shall not be required more than an average of 6 times per year. Corrective maintenance to correct non-critical failures shall not interrupt or degrade the performance of any WCP system function.

3.2.5 Inherent Availability. The WCP hardware and operating software shall have an inherent availability of .999967 or greater. The WCP inherent availability requirement excludes non-critical equipment (tape drive, CRT terminal and printer) and FAA-supplied air conditioning and power. The inherent availability shall be calculated as follows:

$$\text{Inherent Availability} = \frac{\text{MTBCF}(\text{hardware})}{\text{MTBCF}(\text{hardware}) + \text{MTTR}(\text{hardware})} \times \frac{\text{MTBCF}(\text{software}^*)}{\text{MTBCF}(\text{software}^*) + \text{MTTR}(\text{software}^{**})}$$

\* MTBCF of the operating system software.

\*\* MTTR functions of the operating system software (5 minutes, maximum) plus 5 minutes additional to restore the operation of the applications software.

3.2.6 Environmental Conditions. The WCP shall be designed to comply with the following environmental conditions that may be encountered during the transportation, storage and operation of the system.

The WCP shall be designed for operating and non-operating environmental conditions defined in Table 3.2.6.1-1. All specification requirements for operating under service conditions shall be met when the equipment is operating at the specified duty cycle. Operating service conditions, defined in 3.2.2.4, apply under all fixed or slowly varying conditions of AC line voltage and frequency defined in FAA-G-2100. Non-operating conditions include shipping and handling, storage, and installations that are not operating. If the equipment is designed to the non-operating condition, then design verification test results equal to or beyond these conditions shall be provided; otherwise the protective containers and/or an environmental control system shall be provided so the stated non-operating condition is not experienced by the equipment, i.e., in such a case, the operating condition limits are met.

Table 3.2.6.1-1 WCP Environment

| <u>Environment</u>                     | <u>Equipment<br/>Operating</u> | <u>Equipment<br/>Non-Operating</u> |
|--|--------------------------------|------------------------------------|
| Altitude, ft                           | 0 to 10,000                    | 0 to 50,000                        |
| Temperature, °C                        | +10 to +35                     | -50 to +70                         |
| Humidity, %RH @ 23°C<br>non-condensing | 20 to 80                       | Up to 100                          |

### 3.3 Design and Construction.

3.3.1 Materials, Processes, and Parts. Procedures shall exist for the WCP off-the-shelf designs to manage corrosion, dissimilar metals, noxious materials, and material compatibility.

3.3.1.1 Corrosion. Corrosion control and monitoring shall be in accordance with MIL-HDBK-721.

3.3.1.2 Dissimilar Metals. Dissimilar metals shall not be used where their use will degrade or cause deterioration to the assembled parts. When dissimilar metals are used, they shall be coated or protected to prevent degradation to other parts and assemblies. For WCP development, the precepts established in MIL-STD-889, Dissimilar Metals, shall be followed.

3.3.2 Electromagnetic Radiation. The WCP equipment shall meet the conducted and radiated emission requirements of Federal Communications Commission (FCC) Rules and Regulations (FCC Part 15).

3.3.3 Interchangeability. All WCP equipment shall be constructed with like units, assemblies, subassemblies and replaceable parts being physically and functionally interchangeable, without modifications to such items or the equipment. Wherever practical, modular construction shall be used and appropriate consideration given to the use of integrated circuits. Each equipment unit shall permit item replacement without removal of adjacent units and permit ready access to all items.

The number of item types shall be kept to a minimum in order to keep the number of unused elements or spare modules to a minimum. Plug-in components shall be standardized as to size and function to the maximum extent possible.

3.3.4 Safety. The WCP system shall comply with Occupational Safety and Health Administration (OSHA) Safety and Health Standards (29 CFR 1910).

3.4 Documentation. All necessary services and materials required to develop, prepare, and deliver to the Government the documentation specified herein, shall be provided in accordance with the formats, quantities and submittal schedules specified in the contract schedule. All specified documentation shall be maintained current throughout the contract life cycle. All documents subject to change (e.g., plans, manuals, etc.) shall be processed in the form of replace or change pages or by revision of the entire document when more than 50 percent of the document is affected by the revision.

All documents developed, prepared, updated or delivered shall be prepared in accordance with the contract schedule and the following requirements:

- 1) Technical documents shall be numbered on each page. All documents shall have the date on the cover page. Revision pages shall each be numbered and shall include the revision date and revision letter, starting with "A" for the first revision.
- 2) Engineering drawings and associated lists shall be to the LRU and shall be DOD-D-1000 Level 2, company standard.
- 3) All documents shall be prepared using correct English and a minimum of abbreviations and acronyms. Correct spelling and punctuation shall be used in clear, direct sentences. Effective and unambiguous communication of the intended information shall be the goal of each document.

Detailed documentation for all elements of the supplied WCP system shall be included. This documentation shall include, as a minimum, the items defined below. All documentation items described in the subparagraphs below shall be prepared as described in the contract schedule. The number of copies and the delivery schedule for these items shall be as defined in the contract schedule. The hardware and software shall be documented as defined in the following subparagraphs.

3.4.1 Hardware Documentation. All hardware documentation shall be developed in accordance with the contract schedule. The following hardware documentation shall be included:

- 1) Hardware system overview - This documentation shall describe the overall operational hardware configuration.
- 2) Detailed hardware instruction manuals - The instruction manual shall include sufficient level of detail on the hardware and the interactions with the supplied system software (operating system, communications, and fault detection, isolation and recovery related) to provide a thorough understanding of all hardware and system software functions.
- 3) System maintenance manual - This manual shall provide a complete definition of hardware maintenance procedures. The maintenance manual shall include theory of operation of the hardware and support software, fault isolation procedures and detailed instructions for the replacement of each LRU used within the system.
- 4) Operation manual - This manual shall fully describe the operation of all supplied system hardware.
- 5) Each item of equipment shall have an attached nameplate and each LRU shall have a permanent serial number, in accordance with IEEE 200-75.

3.4.2 Software Documentation. Software documentation developed shall be in accordance with DOD-STD-2167. Commercial documentation shall be provided for commercial-off-the-shelf (COTS) software. The following documentation for the supplied support software as specified in 3.1.3, including that provided with the WCP software development system as specified in 3.1.4, shall be included.

Detailed users manuals shall be included for all supplied software items including hardware and software interfaces and interactions. All supplied software shall be fully documented to permit its integration with government developed applications software.

### 3.5 Logistics

This section sets forth the overall requirements for hardware and system support software maintenance, logistics support, and the facilities and facility equipment impacted by the WCP. Specific logistics requirements are defined in the contract schedule.

An Integrated Logistics Support (ILS) approach shall be used to evaluate the impact of design alternatives on the cost of ownership; determine a cost-effective maintenance plan for equipment parts, printed circuit boards/modules/assemblies which, when failure occurs, can be removed and replaced to restore the system to operation; determine a cost-effective maintenance plan for software; and guide the elements of logistics in planning, developing, and implementing the support system.

The WCP design and integrated logistics support approach shall also address:

- a. Ensuring that overall mission needs are met and the total overall cost of ownership is minimized.
- b. Providing more efficient maintenance service despite budget and personnel position ceilings.
- c. Improving system support software maintenance through the use of modern software maintenance concepts.
- d. Training.

3.5.1 Hardware Maintenance Requirements and Analysis. The hardware maintenance requirements of the design shall be augmented with maintenance features which make support compatible with the maintenance concept. These maintenance features shall reduce repair time by providing the technician with the ability to diagnose a malfunction rapidly, identify the failed unit, and replace it quickly. Maintenance features shall include internal on line diagnostics to identify the failed unit, simple removal and replacement maintenance methods to restore the equipment to an operable condition, and built-in test equipment to aid in fault isolation.

3.5.2 Maintenance Concept. Maintenance of the WCP shall comply with the maintenance philosophy and projected concept described in FAA Order 6000.27A. Hardware maintenance shall consist of two types: Corrective maintenance (CM) and preventive/periodic maintenance (PM). Maintenance shall be performed by a relatively small, multi-skilled technical work force. Routine periodic maintenance shall be performed no more than 4 times per year.

3.5.2.1 Periodic Maintenance. Periodic maintenance is defined as all actions performed to maintain the WCP in operational condition, including systematic inspection and certification. As part of the maintenance planning, periodic maintenance schedules shall be developed to check or recondition the WCP to prevent or reduce the probability of a failure or degradation in subsequent service. Periodic maintenance activities shall not interfere with normal FAA facility operations. The system/equipment design shall limit the frequency and duration of periodic maintenance tasks to 4 visits per year, 4 hours per visit, maximum. The resultant system characteristics shall minimize periodic maintenance tasks and minimize the number of facility/equipment site visits. Periodic maintenance tasks and periodicity shall be flexible enough to allow for periodic maintenance to be accomplished in conjunction with corrective maintenance tasks.

**3.5.2.2 Corrective Maintenance.** Corrective maintenance is defined as all actions performed to locate and replace a failed LRU. As part of maintenance planning, trouble/cause tables shall be included in documentation used by maintenance technicians performing corrective maintenance procedures. Corrective maintenance is initiated following notification that equipment is inoperative (off-line) or that degradation of function has occurred or it has been determined that failure is imminent. The equipment shall be designed for ease of equipment/system maintenance by removal and replacement of a faulty LRU with a serviceable spare without interruption of service. The LRU is a designated field replaceable item.

**3.5.3 Maintenance Levels.** Maintenance availability of FAA facilities is the prime functional responsibility of FAA field maintenance personnel.

The system design for maintenance shall be predicated on the following levels of maintenance activity for maximum responsiveness; productivity, and efficiency in utilization of maintenance personnel resources. The levels consist of (1) On-site maintenance, (2) Intermediate (work center) Maintenance, and (3) Depot Maintenance.

**3.5.3.1 On-site Maintenance.** The FAA on-site maintenance constitutes periodic maintenance and repair actions as required to maintain the WCP in fully operational status. On-site maintenance shall be conducted in accordance with policy and guidance set forth in FAA Order 6000.27. On-site maintenance shall also include non-routine repair actions requiring system analysis of faults, troubleshooting, and testing in accordance with equipment manuals, logic diagrams, or manufacturer's handbooks to identify faulty components, units, or assemblies and to effect repair.

**3.5.3.1.1 On-site Maintenance Responsibility.** Direct on-site maintenance shall be the responsibility of and shall be performed by technical personnel located at the WCP equipment. This maintenance shall consist of periodic checks of equipment, monitoring performance, inspecting, cleaning, servicing, diagnosing and isolating system/equipment faults to a failed LRU, removing and replacing the LRU, and checking out the system/equipment to certify its performance.

**3.5.3.1.2 Certification.** Certification shall demonstrate that the WCP is capable of providing the required/specified services to the user. The WCP shall be designed to support certification at unit, subsystem, and system levels. Certification programs shall be designed to operate on line and these programs shall not interfere with the operational use of the system.

**3.5.3.1.3 Repair of Failed LRUs.** All repairable LRUs are forwarded to the appropriate maintenance facility in accordance with FAA policy. Depot maintenance has the responsibility for LRU repairs.

**3.5.3.2 Intermediate Work Center Maintenance.** Maintenance is performed at this level in direct support of site-level maintenance and involves disposition, repair, service, calibration, and verification of items removed during site maintenance. It normally excludes activities requiring equipment, facilities, or skills that can be provided more economically at the Depot level.

**3.5.3.3 FAA Depot Maintenance.** The Depot maintenance facilities shall provide support for repair, alignment, and calibration of complex equipment and modules requiring specialized equipment and procedures. This facility provides the maintenance capability for completely overhauling and rebuilding equipment as well as the performance of highly complex maintenance actions which are beyond the resources of the field maintenance organization. The Depot also serves as the major logistics support facility for field accomplishment of on-site maintenance activities.

The Depot is an FAA facility which, at its option, may contract repair of an LRU to a vendor facility when such repair is more cost-effective.

3.5.4 Spares. Spare parts shall be provided in accordance with the contract schedule. The government may not maintain spares on-site at the WCP system locations and at the FAA Depot, or solely at the FAA Depot. Each spare LRU shall be individually packaged and the container labelled with a stock number. The contractor shall host a provisioning conference with Government participation. The labelling of spares will be defined by representatives from the government depot at the provisioning conference. The type, quantity and stocking locations of spares will be determined by the Government subsequent to a provisioning conference as defined in the contract schedule. The schedule for the provisioning conference shall be as defined in the contract schedule.

3.5.5 Maintenance Personnel. Maintenance planning shall consider the levels of maintenance personnel. The WCP shall be designed such that all corrective, periodic and software maintenance will use staffing at/or below the current levels throughout the equipment/system life.

3.5.6 Training. Training to government personnel for the WCP system shall be provided. This training shall include the operation and maintenance of the WCP hardware and operating system software. The training provided shall be in accordance with the requirements defined in the , following subparagraphs and with FAA Standard for Contract Training Programs (FAA-STD-028).

3.5.7 Configuration Management. Configuration Management shall be implemented consistent with FAA-STD-021 and in accordance with the requirements of the contract schedule.

#### 4. QUALITY ASSURANCE PROVISIONS

4.1 General. Testing shall ensure that all hardware and system support software/firmware is in accordance with all WCP contract requirements. All test activities shall be in accordance with the contract schedule and approved WCP test plans. Applicable standards are listed in this section and in the contract schedule.

4.1.1 Responsibility for Tests. Test plans for the tests required in the following subparagraphs shall be submitted to the government for approval. Following the approval of all relevant test plans and procedures, the tests (hardware and/or software/firmware, where appropriate) defined in the following subparagraphs shall be conducted.

The WCP shall be tested to demonstrate, verify, and validate compliance with all functional and performance requirements stated in this specification. WCP testing shall be based on a bottom-up building-block approach that takes a defined subset of WCP requirements and validates compliance of that building block with its requirements before proceeding to validate the next higher level of integration. Major test series shall progress from the subsystem level up to the system test level. Special test requirements shall be developed to accommodate each test phase. Functional capabilities of each successive building-block increase until the final building block implements all WCP system requirements. Test reports shall be written and submitted for review and regression tests shall be performed when required by the contract schedule. Regression tests shall consist of tests that are repeated after software or hardware changes have been implemented, or upon delivery of software updates.

4.1.2 Qualification Methods. The methodology used to verify adherence of the WCP to the requirements specified in Section 3 includes: inspection, analysis, demonstration, and test. (See Section 4.4 for definition of these terms). These methods, used singularly or in combination with manual or automated techniques, are generally applicable to both developmental and operational testing. Each requirement and method of verification shall be presented in tabular form.

4.1.3 Test Levels. The SOW will define the level of testing that shall be applied to each delivered system. WCP testing shall be structured in the following three categories:

- Initial Qualification Test - Initial Qualification Test shall consist of verification of all specification requirements.
- Factory Acceptance Test - Factory Acceptance Test (FAT) shall consist of pre-shipment system level testing.
- Site Acceptance Test - Site Acceptance Test (SAT) shall consist of post-shipment system level testing.

4.1.3.1 Initial Qualification Test. This test shall be performed on the first delivered system (excluding the software development system) to verify compliance with all requirements of this specification.

4.1.3.2 Factory Acceptance Test. This test (otherwise known as a pre-shipment system test) is performed to validate the function of the system at the contractor test facility and is witnessed by the government. The FAT shall demonstrate the adequacy of the WCP design by testing all aspects of system function and performance as defined in this specification. The FAT plan shall define the range of tests, input data, initialization requirements, personnel, equipment facilities and schedules shall also be identified. Upon the successful completion of the FAT, each WCP shall be transported to and installed at its intended field test environment.

4.1.3.3 Site Acceptance Test. This test (otherwise known as a field site installation and checkout test or a post-shipment system test) is performed to validate the function of the system in its intended field test environment. Additionally, the SAT will demonstrate the adequacy of the design, packaging, handling, and transportation capability of the WCP in transit. With the successful completion of the SAT, each WCP shall be ready for government evaluation testing. The SAT plan shall present descriptions and test success criteria for transferring the WCP systems from the test environment to the FAA's ARTCC/ACF and for checkout testing. This test plan shall define the range of tests, input data, initialization requirements, expected output, and criteria for evaluating test results. Testing resources such as personnel equipment, facilities, and schedules shall also be identified.

4.1.4 Quality Conformance Requirements. Each formal test plan shall delineate each specific WCP requirement to be demonstrated during the test. Included with each requirement shall be an indication of the method to be used to demonstrate the requirement, the expected output or results, and how the results will be analyzed to determine success or failure. In each formal test procedure, the requirement identification shall be noted at the beginning of the procedure steps which test the requirement. Requirement identification shall consist of the section/paragraph number used in Section 3 of this specification. Each test report shall contain a section that delineates all requirements demonstrated during the test followed by an indication of the actual output or results and a statement concerning the success or failure of the demonstration. The Qualification Cross-Reference Table described in 4.4 shall be included and maintained in formal test plans. The test report for each test plan shall reflect the relative completeness of requirements satisfaction.

4.2 Formal Tests. Formal test requirements documents shall be developed for FAT and SAT phases. FAT and SAT requirements documents are to include reliability testing requirements. Formal test requirement documents and specified standards shall provide the basis for development of detailed Test Plans and Procedures documentation for FAT and SAT testing. The activities associated with the aforementioned tests shall be rigorously documented and controlled. Each test shall be documented with Test Plans, detailed Test Procedures and Test Reports per FAA-STD-024 and the data requirements of the WCP contract.

4.3 Formal Test Constraints. The configuration of the WCP shall remain the same during FAT and SAT testing.

4.4 Qualification Cross-Reference Table. The following is a methodology used to verify adherence to requirements specified in Section 3. The verification methods include inspection, analysis, demonstration and test. Each requirement and method of verification shall be presented in tabular form.

These verification requirements shall be mandatory for use in all testing of the WCP. Where applicable, pass/fail criteria for each verified requirement shall be defined and placed in the appropriate documentation. Failure to "pass" the appropriate verification action(s) (inspection, analysis, demonstration, or test) shall be cause for rejection. Upon evaluation of the cause of the failure and the implementation of proper corrective measures, the verification in which the failure occurred shall be repeated. If the corrective action has an impact on prior verifications, if a computer program is changed, or if any hardware is changed, then the prior verification shall be repeated. The Qualification Cross-Reference Table (Table 4.4-1) shows the test methods that shall be used for verifying compliance with the requirements of the specification. Specific allocation of test requirements for the Initial Qualification Test, the SAT and the FAT, are listed in the SOW. Each verification method is detailed in the following sections.

4.4.1 Inspection (I). Inspection is verification by visual examination of the item, reviewing descriptive documentation and comparing the appropriate characteristics with a predetermined or referenced standard to determine conformance to requirements without the use of special laboratory equipment or procedures.

4.4.2 Analysis (A). Analysis is verification by technical/mathematical evaluation or simulation using mathematical representation (i.e., mathematical models, algorithms, equation), charts, graphs, circuit diagrams, data reduction/recording and representative data to prove that an item meets specified requirements. Representative data may include data collected from previous or other equipment and system verifications.

4.4.3 Demonstration (D). Demonstration is an uninstrumented test, where success is determined from observation alone. Included in this category are tests whose results can easily be determined on a pass-fail basis.

4.4.4 Test (T). Test is verification, through systematic exercising of the item under all appropriate conditions with collection, analysis, and evaluation of quantitative data for predetermined performance characteristics. Acceptability of the item is determined by the comparison of the data with pre-established quantitative requirements and occurrences.

Table 4.4-1 Qualification Cross-Reference Table

| Paragraph | Paragraph Name   | Method |
|-----------|--|--------|
| 3.        | REQUIREMENTS   | -      |
| 3.1       | WCP Hardware and System Support Software Definition    | A,D,T  |
| 3.1.1     | Interface Definition                                   | -      |
| 3.1.1.1   | Mode S Interface                                       | I,D,T  |
| 3.1.1.2   | NADIN II Interface                                     | I,D,T  |
| 3.1.1.3   | Maintenance Processor Subsystem (MPS) Interface        | I,D,T  |
| 3.1.1.4   | Coded Time Source (CTS) Interface                      | I,D,T  |
| 3.1.1.5   | CRT Terminal Interface                                 | I,D,T  |
| 3.1.1.6   | Printer Interface                                      | I,D,T  |
| 3.1.1.7   | Spare Interface Ports                                  | I,D,T  |
| 3.1.2     | Components List  | I      |
| 3.1.2.1   | Reserved   | -      |
| 3.1.2.2   | Reserved   | -      |
| 3.1.2.3   | Operational Configuration - Hardware Requirements      | -      |
| 3.1.2.3.1 | Application Processor(s) Requirements                  | I,D    |
| 3.1.2.3.2 | Application Memory Requirements                        | I,D    |
| 3.1.2.3.3 | Mass Storage Requirements                              | I,D    |
| 3.1.2.3.4 | Magnetic Tape Requirements                             | I,D    |
| 3.1.2.3.5 | Communications Interface Requirements                  | I,D    |
| 3.1.2.3.6 | Real Time Clock Requirements                           | I,D,T  |
| 3.1.2.3.7 | CRT Terminal Requirements                              | I,D    |
| 3.1.2.3.8 | Printer Requirements                                   | I,D    |
| 3.1.2.3.9 | Cable and Connector Requirements                       | I      |
| 3.1.2.4   | Support Configuration - Hardware Requirements          | -      |
| 3.1.2.4.1 | Support System Application Memory Requirements         | I,D    |
| 3.1.2.4.2 | Support System CRT Terminal Requirements               | I,D    |
| 3.1.2.4.3 | Support System Printer Requirements                    | I,D    |
| 3.1.3     | System Support Software                                | I,D    |
| 3.1.3.1   | Operating System                                       | D,T    |
| 3.1.3.2   | CCITT X.25 Communications Software/Firmware            | I,T    |
| 3.1.3.3   | LAPB Communications Software/Firmware                  | I,T    |
| 3.1.3.4   | ANSI Standard X3.28 Communications Software            | I,T    |
| 3.1.3.5   | Reserved   | -      |
| 3.1.3.6   | CCITT Recommendation X.224 Communications Software     | I,T    |
| 3.1.3.7   | Maintenance Software                                   | D,T    |
| 3.1.3.8   | Other Communications Software                          | I,D,T  |
| 3.1.4     | Support Software for Applications Software Development | I,D    |
| 3.1.4.1   | Compilers  | I,D    |
| 3.1.4.2   | Assembler  | I,D    |
| 3.1.4.3   | Symbolic Debugger                                      | I,D    |
| 3.1.4.4   | Text Editor  | I,D    |
| 3.1.4.5   | Linking Loader   | I,D    |
| 3.1.4.6   | Library Update Utilities                               | I,D    |
| 3.1.4.7   | Mathematical Subroutine Library                        | I,D    |

Table 4.4-1 Qualification Cross-Reference Table (Cont'd)

| Paragraph   | Paragraph Name                         | Method |
|-------------|--|--------|
| 3.2         | System Characteristics                 | -      |
| 3.2.1       | Performance                            | -      |
| 3.2.1.1     | Reserved                               | -      |
| 3.2.1.2     | Performance                            | -      |
| 3.2.1.2.1   | Application Processor Performance      | T      |
| 3.2.1.2.2   | Memory Performance                     | D,T    |
| 3.2.1.2.3   | Mass Storage Device Performance        | D,T    |
| 3.2.1.2.4   | Magnetic Tape Drive Performance        | D,T    |
| 3.2.1.2.5   | External Interface Performance         | I,D,T  |
| 3.2.1.2.6   | Real Time Clock Performance            | I,D,T  |
| 3.2.1.2.7   | CRT Terminal Performance               | D,T    |
| 3.2.1.2.8   | Printer Performance                    | -      |
| 3.2.1.2.8.1 | Operational System Printer Performance | D,T    |
| 3.2.1.2.8.2 | Support System Printer Performance     | D      |
| 3.2.2       | Physical Characteristics               | -      |
| 3.2.2.1     | Weight Limits                          | I      |
| 3.2.2.2     | Dimensional Limits                     | -      |
| 3.2.2.2.1   | Accessibility                          | I      |
| 3.2.2.2.2   | Access Clearance                       | I      |
| 3.2.2.3     | Durability                             | I      |
| 3.2.2.4     | Power Requirements                     | T      |
| 3.2.2.5     | Electrical Grounding/Interfacing       | -      |
| 3.2.2.5.1   | Grounding and Bonding                  | I      |
| 3.2.2.5.2   | Grounding Networks                     | -      |
| 3.2.2.5.2.1 | AC Ground                              | I      |
| 3.2.2.5.2.2 | Chassis Ground                         | I,T    |
| 3.2.2.5.2.3 | Signal Ground                          | I      |
| 3.2.2.5.2.4 | Circuit Ground                         | I      |
| 3.2.2.5.2.5 | Return Paths                           | I      |
| 3.2.2.5.2.6 | Electrostatic Discharge (ESD)          | I      |
| 3.2.2.6     | Wiring                                 | I      |
| 3.2.2.7     | Cooling                                | -      |
| 3.2.2.7.1   | Internal Temperature                   | D      |
| 3.2.2.7.2   | Airflow                                | I      |
| 3.2.2.7.3   | Forced-Air Cooling                     | I      |
| 3.2.3       | Reliability                            | A,D    |
| 3.2.4       | Maintainability                        | -      |
| 3.2.4.1     | Mean Time to Restore (MTTR)            | D      |
| 3.2.4.2     | Line Replaceable Unit (LRU)            | -      |
| 3.2.4.3     | Fault-Isolation                        | D,T    |
| 3.2.4.4     | Preventive Maintenance                 | I      |
| 3.2.4.5     | Corrective Maintenance                 | I      |

Table 4.4-1 Qualification Cross-Reference Table (Concluded)

| Paragraph | Paragraph Name                                 | Method |
|-----------|--|--------|
| 3.2.5     | Inherent Availability                          | A      |
| 3.2.6     | Environmental Conditions                       | I,T    |
| 3.3       | Design and Construction                        | -      |
| 3.3.1     | Materials, Processes, and Parts                | I      |
| 3.3.1.1   | Corrosion                                      | I      |
| 3.3.1.2   | Dissimilar Metals                              | I      |
| 3.3.2     | Electromagnetic Radiation                      | I      |
| 3.3.3     | Interchangeability                             | I      |
| 3.3.4     | Safety   | I      |
| 3.4       | Documentation                                  | -      |
| 3.4.1     | Hardware Documentation                         | -      |
| 3.4.2     | Software Documentation                         | -      |
| 3.5       | Logistics                                      | -      |
| 3.5.1     | Hardware Maintenance Requirements and Analysis | -      |
| 3.5.2     | Maintenance Concept                            | -      |
| 3.5.2.1   | Periodic Maintenance                           | -      |
| 3.5.2.2   | Corrective Maintenance                         | -      |
| 3.5.3     | Maintenance Levels                             | -      |
| 3.5.3.1   | On-site Maintenance                            | -      |
| 3.5.3.1.1 | On-site Maintenance Responsibility             | -      |
| 3.5.3.1.2 | Certification                                  | -      |
| 3.5.3.1.3 | Repair of Failed LRUs                          | -      |
| 3.5.3.2   | Intermediate Work Center Maintenance           | -      |
| 3.5.3.3   | FAA Depot Maintenance                          | -      |
| 3.5.4     | Spares   | -      |
| 3.5.5     | Maintenance Personnel                          | -      |
| 3.5.6     | Training                                       | -      |
| 3.5.7     | Configuration Management                       | -      |

## 5. PREPARATION FOR DELIVERY

### 5.1 General.

5.1.1 Level of Preservation Protection. The level of packing shall afford protection against corrosion, deterioration, and physical damage during shipment from the supply source to the first receiving activity where the item may be subject to immediate use or storage.

5.1.2 Level of Packing Protection. The level of packing shall afford protection against damage during direct domestic shipment from the supply source to the first receiving activity for immediate use. The level, in general, will conform to applicable carrier rules and regulations.

5.2 Packing. Equipment packed for shipment shall be packed such that it will not be damaged in transit. The equipment shall be examined and suitably packed for heavy components such as transformers which may need additional bracing or support to avoid damage in the event the container is dropped during handling.

5.2.1 Blocking and Bracing. Unless otherwise secured, items that do not completely fill the container shall be blocked and braced to prevent movement inside the container. Items having projecting parts that are subject to damage or that would tend to damage the barrier media shall be rigidly supported. Blocking or bracing shall be applied against areas of the items that are of sufficient strength and rigidity to resist damage. Distribution of supports to several points or to a large area of the item shall be provided.

Ends of wood blocks or braces shall not be fastened to a wood container by end-grain nailing, toe nailing, or similar method; they shall be fastened to sturdy parts of areas of the container, or held in grooves formed by parallel cleats or securely socketed.

5.2.2 Cushioning. Cushioning materials (or devices) shall be used to protect the contents and the preservation and packaging components from physical damage. The cushioning medium shall be placed as close to the items as practical to prevent flexible barrier rupture and to ensure against free movement in rigid containers.

5.2.3 Bolting. Items such as subassemblies, having bolt holes in part of the item which is sturdy enough to resist breakage when handled roughly, shall, if practical, be bolted to one face of the container. In instances involving nonprecision bolt holes, the diameter of the bolt shall be the nearest standard size consistent with the diameter of the hole. In instances involving precision bolt holes, precision fitting bolts of proper characteristics shall be used to prevent marring or elongation; lag screws or lag bolts shall not be used. Holes bored through containers or mounting bases shall be the same size as the diameter of the bolt used. When container bases are provided with skids, the bolts shall extend through the skids whenever practical, and the bolts shall be countersunk in the outer surface of the skid.

Standard cut washers shall be used under nuts to make contact with wood. To ensure that the nuts will not come loose in transit, they must be positively secured by upsetting or nicking the threads of the bolt beyond the nut; by applying asphaltum, paint, or lacquer on the threads; by use of lock nuts; or by use of cotter pins with nuts. Prior to use, bolts and nuts without corrosion-resistant finish shall be completely covered with a corrosion-preventive compound.

5.2.4 Packing Small Components and Material. Small individual items or components shall be packed and marked both internally and on the exterior surface of the containers.

5.2.5 Packing for Spares and Storage. All spare parts shall be individually packaged and packed for delivery and/or storage in accordance with the best industry practices. Packages for spares shall be labelled as agreed to at the provisioning conference, as detailed in Section 3.5.1.

5.2.6 Barrier Material. A sealed, water/vaporproof bag or equivalent shall provide a protective wrapping over all WCP components and equipment.

5.2.7 Items Included in Packing. The following items shall be included as defined in the contract:

- 1) Documentation
- 2) Spare parts
- 3) Cables and accessory items furnished with the equipment
- 4) Modification records
- 5) Any parts or assemblies removed for reasons other than an agency-wide modification. This would include any item removed to satisfy conditions unique to one facility, but which may be needed if the equipment should be installed at another facility
- 6) Any modification kits on hand, but not installed in the equipment to be transferred
- 7) Other necessary records (e.g., repair logbook, etc.)
- 8) Operating system software (on 9-track tape).

5.2.8 Marking. Each shipping container shall be marked to allow identification of contents without unpacking. Marking requirements, including materials, methods, and sizes of markings, shall be in accordance that agreed to at the provisioning conference.

5.2.9 Packing List. Each individual shipping container, or one container of each shipment, shall contain a packing list enclosed in one container of the group. That container shall be clearly marked "PACKING LIST INSIDE." It is also permissible to place the packing list in a heavy envelope marked "PACKING LIST," and securely fasten it to one of the containers.

5.3 Shipment. Shipment of all material and equipment required for WCP installation at any site listed in the contract schedule shall be the responsibility of the contractor, including off-loading and emplacement of equipment.

## 6. NOTES

### 6.1 Acronyms.

|        |  |
|--------|--|
| A      | Analysis   |
| AC     | Alternating Current  |
| ACF    | Area Control Facility  |
| ADAS   | AWOS Data Acquisition System                                     |
| ADCCP  | Advanced Data Communication Control Procedure                    |
| ANSI   | American National Standards Institute                            |
| ARTCC  | Air Route Traffic Control Center                                 |
| ASCII  | American Standard Code for Information Interchange               |
| ATC    | Air Traffic Control  |
| AT&T   | American Telephone and Telegraph                                 |
| AWOS   | Automated Weather Observing System                               |
| BIT    | Built-In Test  |
| BITE   | Built-In Test Equipment  |
| b/s    | bits per second  |
| CCITT  | Consultative Committee on International Telegraphy and Telephony |
| CM     | Corrective Maintenance   |
| CRT    | Cathode Ray Tube   |
| CTS    | Coded Time Source  |
| D      | Demonstration  |
| DC     | Direct Current   |
| DCE    | Data Circuit-Terminating Equipment                               |
| DOD    | Department of Defense  |
| DTE    | Data Terminal Equipment  |
| EIA    | Electronic Industries Association                                |
| ESD    | Electrostatic Discharge  |
| FAA    | Federal Aviation Administration                                  |
| FAATC  | FAA Technical Center   |
| FAT    | Factory Acceptance Test  |
| FCC    | Federal Communications Commission                                |
| FIPS   | Federal Information Processing Standard                          |
| I      | Inspection   |
| I/O    | input/output   |
| IEEE   | Institute of Electrical and Electronic Engineers                 |
| ILS    | Integrated Logistics Support                                     |
| IRD    | Interface Requirements Document                                  |
| ISO    | International Standards Organization                             |
| LAPB   | Link Access Procedure Balanced                                   |
| LCN    | Local Communications Network                                     |
| LRU    | Line Replaceable Unit  |
| MB     | million bytes  |
| MIPS   | million instructions per second                                  |
| Mode S | Mode Select Beacon System  |
| MPS    | Maintenance Processor Subsystem                                  |
| MTBCF  | Mean Time Between Critical Failure                               |
| MTBF   | Mean Time Between Failure  |
| MTTR   | Mean Time to Restore   |
| NADIN  | National Airspace Data Interchange Network                       |
| NAS    | National Airspace System   |

|       |   |
|-------|---|
| NEC   | National Electrical Code                      |
| NFPA  | National Fire Protection Association          |
| NTIS  | National Technical Information Service        |
| OSHA  | Occupational Safety and Health Administration |
| PCS   | Power Conditioning System                     |
| PM    | Preventive/Periodic Maintenance               |
| PUB   | Publication                                   |
| RAM   | Random Access Memory                          |
| RH    | Relative Humidity                             |
| SAT   | Site Acceptance Test                          |
| SOW   | Statement of Work                             |
| T     | Test  |
| UTC   | Universal Coordinated Time                    |
| VAC   | Volts - Alternating Current                   |
| WCP   | Weather Communications Processor              |
| WMSCR | Weather Message Switching Center Replacement  |



